RESEARCH PROBLEM STATEMENT #PA-502

I – Problem Title

Investigation of vehicle tires noise on bridge decks (SO21)

II – Research Problem Statement

Question: How does the Department achieve a bridge deck finish that provides adequate skid resistance, channels rainfall away, and provides the least tire noise? The concrete deck surfaces for bridges are constructed with a variety of macro-texture surface finishes. The different surface finishes result in a wide range of tire noise levels that are increasingly perceived as offensive by adjacent residents. Replacement bridges in urban areas need to use the most favorable deck finish available to minimize tire noise. Contractors and State DOTs need to know what the most favorable deck finishing texture is that will provide the required skid resistance, accommodate water runoff, and minimize tire noise.

III – Objective

The objective of this research is to develop a specification for deck finishing that meets the performance needs skid resistance and water dispersion, while producing minimal tire noise.

* Determine if deck surfaces finished with longitudinal tining/brooming provides a surface that is equally safe when compared to a finish that is applied transversely.
* Determine if there is a noise intensity correlation between bridges with a finish applied longitudinally verses transversely.
* Determine the cause and how to avoid the harmonic resonating tire noise that seemingly is produced by the repetitive texture applied by the industry standard finish apparatus.
* Establish a rating relative to the performance needs, skid resistance, water runoff, and tire noise for all the finish types used in California. The rating should be analogous and incorporate cost.

<u>Deliverables</u>:

* Provide a draft specification for deck finishing that meets the performance needs, skid resistance and water runoff, while producing the minimal tire noise.
* Provide a report representing the research conclusions for distinguishing whether longitudinal tining/brooming provides a surface that is equally safe to a finish that is applied transversely.
* Provide a report representing the research conclusions for distinguishing whether there is a correlation between bridges with a finish applied longitudinal verses transversely.
* Provide a report representing the research conclusions related to the cause and how to avoid the harmonic resonating tire noise that is produced by the repetitive texture applied by the industry standard finish apparatus.
* Provide a report representing the research conclusions for finish type ratings relative to the performance needs, skid resistance, water dispersion, and tire noise for all the finish types used in California.

IV – Background

Currently, in California the specification for finishing bridge decks are limited to the ride ability or smoothness and friction. The macro-texture surface finishes on the bridge decks are typically performed in the transverse direction. The types of macro-texture surface finishes are normally metal tining, burlap rug, astro turf, and broom. The tire noise on bridge decks are directly relate to the macro-texture type, depth, and direction.
In addition, there are other factors that affect the tire noise produced on bridge decks. For example, the concrete must be consistent and within the specification for moisture content. Otherwise, the wet and dryer concrete will produce a more different texture depth and correspondingly different tire noise.

There are more and more complaints regarding excessive tire noise produced by normal traffic on bridge decks. For example, in a rural area on Interstate 5 near Redding California, residents near the Sacramento River Bridge got the local politician's attention with their problem related to excessive tire noise produced on the recently widened portion of the bridge. The Department was consulted and the results of a study indicated that the tire noise generated was the loudest measured by this research team. A contract change order had to be initiated to amend the noisy deck by doing surface grinding. Upon completion of longitudinal grinding the noise measured on California bridge decks have a range from 102db to 112db. For reference, a typical power lawn mower is 100db. An increase in 10 db indicates a sound intensity 10 times greater.

V – Statement of Urgency and Benefits

The successful resolution of this problem would support the Department's Mission of Improving Mobility and its Goals for Performance and Safety. The State of California is continually widening existing bridges and replacing old bridges. In urban areas tire noise produced on these bridges has a direct impact on constituents that live or work nearby. Therefore, in many cases, the 'mobility' has increased but has not been improved to those nearby if the tire noise level increases. Directly related to the tire noise produced is the friction factor. A minimum friction factor must be accomplished for safety.

Failure to mitigate tire noise costs the state millions of dollars each year in sound wall construction and other alternatives. Caltrans has an opportunity to benefit from the many of hours and millions of dollars spent by others for research relevant to this problem. The ideal for this research is to provide data necessary to implement a 'bridge deck tire noise' specification to limit the noise from the final product and to identify beneficial construction techniques related to the bridge deck finish, to minimize tire/pavement noise. Sound walls on structures are extremely expensive and turning down the volume at the tire/pavement noise source is a much more practical and much less expensive approach to mitigating this noise.

VI –Related Research

* Noise and Texture on PCC Pavements, Results of Multi-State Study final report, Wisconsin DOT, June 2000

* Tire Pavement Noise and Safety Performance, PCC Surface Texture Technical Working Group, May 1996
* What's All the Noise About? , Better Roads, Oct. 2003
* Arizona Makes Some Noise With Quiet Pavements, Engineer News and Record ENR, Feb. 2 2004
* Creating Friction Where Rubber Meets the Road, Better Roads, Oct. 2003
* Evaluation of Minor Improvements, Grooved Pavement, R.Smith & L.Elliot, Office of Traffic California Department Transportation, Report # CA_DOT_TR_2152-11-75-01, Sept. 1975
* Texture and Skid Resistance of Concrete Pavements and Bridge Decks, U.S. Department of Transportation Federal Highway Administration (FHWA), Report #T5140.10, Sept. 1979

VII – Deployment Potential

As a result of this research, the noise levels established will be instrumental for developing construction specification for the acceptable noise levels on bridge deck surfaces.